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MUD DEBRIS DIVERTER FOR EARTH-BORING BIT

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Field of the Invention

This invention relates in general to earth boring bits, and in particular to a diverter located between the bit leg and the back face for diverting debris from the seal area of the cone.

Background of the Invention

A typical rolling cone earth boring bit has a bit body with three legs. Each bit leg has a bearing pin that extends downward and inward. A cone mounts on the bearing pin, the cone having a back face that is closely spaced to a last machined surface on the bit leg. A seal located in a seal gland near the last machined surface seals lubricant within the bearing spaces between the cone and the bearing pin.

While drilling, cuttings and other debris flow around the bit. In some cases, the cuttings tend to migrate into the clearance between the back face and the last machined surface. The debris enters the seal area, resulting in wear to the seal and possibly premature bearing failure.

In the prior art, deflecting pins have been mounted in holes in the last machined surfaces. These pins are closely spaced to the back face of the cone for retarding entry of debris into the seal gland area. While workable, improvements are desired.

Summary of the Invention

In this invention, at least one diverter is mounted in a hole in the bit leg, the diverter having a protruding head that is located adjacent to the back face region. The head is generally wedge-shaped, with a more pointed end facing into the direction of rotation of the cone. The diverter head has an inner side that is generally perpendicular to a radial line emanating from the axis of the bearing pin. The diverter head has an outer side that is at an acute angle relative to the inner side.

The back face region of the cone has inner and outer portions that are flat and perpendicular to the axis of the bearing pin. An annular wall separates the inner and outer portions. The outer portion is spaced by a larger clearance from the last machined surface than the inner portion. The head of the diverter locates in the larger clearance with the inner side of the head closely spaced to the annular wall. The inner side is shaped to substantially follow the contour of the annular wall in a preferred embodiment.

Brief Description of the Drawings

Figure 1 is a vertical sectional view of a portion of a drill bit constructed in accordance with this invention.

Figure 2 is an enlarged vertical sectional view of a last machined surface of the bit leg and a back face region of the cone of the drill bit of Figure 1, showing a diverter member in accordance with the invention.

Figure 3 is an end view of an inner end of the bearing pin on which the cone of Figure 2 is supported, the cone being shown by dotted lines.

Figure 4 is a perspective view of the diverter member shown in the sectional view of Figure 2.

Figure 5 is a sectional view of the diverter member of Figure 2, taken along the line 5- -5 of Figure 2.

Figure 6 is a sectional view similar to Figure 5 but showing an alternate embodiment of the diverter member.

Figure 7 is a sectional view similar to Figure 5 but showing another alternate embodiment of the diverter member.

Figure 8 is a sectional view of the diverter member of Figure 5 but showing another embodiment of the diverter member.

Figure 9 is a sectional view similar to Figure 5, but of another embodiment of the diverter member.

Detailed Description of the Invention

Referring to Figure 1, bit 11 has a body 13 with at least one bit leg 15. Typically, there are three of the bit legs 15. Each bit leg 15 has a bearing pin 17 that extends downward along a bearing pin axis 18 toward an axis of rotation of body 13. A cone 19 with a central cavity 20 mounts rotatably on bearing pin 17, which has a journal bearing surface. Cone 19 has a plurality of cutting elements 21. Cuttings elements 21 may be either hard metal inserts inserted into mating holes as shown, or milled teeth formed on the exterior of cone 19.

Each leg 15 has a pressure compensator 23 and lubricant passages 25 that lead to the journal bearing surfaces between cone 19 and bearing pin 17. Pressure compensator 23 reduces pressure differential between the hydrostatic pressure of the drilling fluid in the well and the pressure of the lubricant in lubricant passage 25. An annular seal 27 is located at the base of bearing pin 17 for sealing the lubricant within the journal bearing. As shown, seal 27 comprises two metal face seal rings and an elastomer energizer, however, seal 27 could be of many different types.

Referring to Figure 2, seal 27 is located within an annular seal gland 31 that is partially on bearing pin 17 and partially on bit leg 15. A last machined surface 29 on bit leg 15 borders seal gland 31 and extends radially outward therefrom relative to bearing pin axis 18 (Figure 1). In this embodiment, seal gland 31 comprises an annular recess. Last machined surface 29 is a flat surface located in a plane perpendicular to axis 18 (Figure 1) of bearing pin 17.

In this embodiment, cone 19 has a flat inner back face portion 33 beginning at cavity 20 and extending outward perpendicular to axis 18 of bearing pin 17. An outer back face portion 35 joins inner back face portion 33. Outer back face portion 35 is also flat and perpendicular to axis

18 (Figure 1) of bearing pin 17, however it is spaced axially from inner back face portion 33, relative to axis 18. An annular wall 37 is located at the junction of inner back face portion 33 with outer back face portion 35, wall 37 preferably being cylindrical. Alternately, wall 37 could be conical or tapered. The clearance between inner back face portion 33 and last machined surface 29 is smaller than the clearance between outer back face portion 35 and last machined surface 29. In this embodiment, outer back face portion 35 extends outward to a gage surface 39. Gage surface 39 is a conical surface that governs the outer diameter of the hole being drilled.

At least one, and preferably a plurality of diverters 41 are mounted to last machined surface 29. As shown in Figure 3, each diverter 41 is circumferentially spaced from the others. In the embodiment shown, each diverter 41 is located approximately 120 degrees apart from the other relative to bearing pin axis 18 (Figure 1). Referring again to Figure 2, each diverter 41 has a base 45 that is interferingly pressed into a hole 43 formed in last machined surface 29. Base 45 is cylindrical and preferably has a top surface that is substantially flush with last machined surface 29. Hole 43 is located so that part of diverter base 45 is located in the smaller clearance area between last machined surface 29 and inner back face portion 33. The innermost portion of diverter base 45 is closer to bearing pin axis 18 than annular wall 37. The outermost portion of diverter base 45 is in a part of the larger clearance between last machined surface 29 and outer back face portion 35.

A head 47 integrally formed on the top of base 45 protrudes into the clearance between last machined surfaced 29 and outer back face portion 35. As shown also in Figures 3-5, head 47 is wedge or triangular-shaped in a transverse cross-section perpendicular to an axis of base 45. Head 47 has a leading side 49 that forms a point or sharper end of head 47, and a trailing side 51

that is 180 degrees from leading side 49. Leading side 49 points into the direction of rotation of cone 19, as indicated by arrow 53 in Figure 3. Leading side 49 is not a sharp point in the first embodiment, but it is considerably narrower than trailing side 51. Leading side 49 and trailing side 51 are curved at the same radius as base 45 in this embodiment. The distance from leading side 49 to trailing side 51 is the same as the diameter of base 45 in this embodiment.

Head 47 also has an inner side 55 and an outer side 57. Inner side 55 is located next to back face annular wall 37. Inner side 55 is offset from and parallel to a diametrical line in the embodiment of Figure 5. Inner side 55 and outer side 57 diverge from each other at an angle that is preferably in the range from about 30 to 45 degrees. As shown in Figure 5, in this first embodiment, outer side 55 is slightly concave, although it could be straight as well. Inner side 55 is also slightly concave at preferably a radius slightly larger than the radius of curvature of back face annular wall 37. Making inner side 55 parallel to a portion of back face annular wall 37 results in a substantially uniform width clearance 58 between diverter head inner side 55 and back face annular wall 37. Clearance 58 extends from leading side 49 to trailing side 51. A radial line 59 (Figure 3) emanating from bearing pin axis 18 passes through head 47 normal to inner side 55 and at an oblique angle relative to outer side 57. Inner side 55 is substantially perpendicular to radial line 59 even though it is slightly concave.

In the operation of the first embodiment, cone 19 rotates in the direction indicated by arrow 53 in Figure 3 during normal drilling operations. Debris flows in the larger clearance between last machined surface 29 and back face portion 35 (Figure 2). This debris tends to rotate with cone 19. When the debris contacts diverter head 47, outer side 57 diverts the debris away from back face annular wall 37 and thus away from the area of seal gland 31 (Figure 2).

While it is preferred to have a diverter head that is wedge-shaped, the configuration of the head can vary, as indicated in Figures 6-9. The components of the alternate embodiments that are the same as in the first embodiment have the same reference numerals as the first embodiment. In Figure 6, as in all of the embodiments, diverter head 61 has a more pointed leading side 67 and a blunter trailing side 69, defining a wedge shape. In this embodiment, inner side 63 is straight, rather than being slightly concave as inner side 55 of the first embodiment. Inner side 63 is substantially perpendicular to radial line 59 (Figure 2) and is located substantially on a diametrical line in this embodiment. Inner side 63 as shown is not precisely parallel to a tangent line of annular wall 37, although it could be. Rather, inner side 63 is shown at a slight angle to a tangent line of annular wall, resulting in a clearance 70 that is slightly narrower at leading side 67 than at trailing side 69. In this embodiment, outer side 65 is slightly concave in the same manner as outer side 57 of the embodiment of Figure 5.

Referring to Figure 7, in this embodiment, diverter head 71 is also wedge-shaped. Inner side 73 is flat, similar to inner side 63 of the Figure 6 embodiment, but it could be concave if desired. Inner side 73 is substantially perpendicular to radial line 59 (Figure 3), although slightly angled as in the Figure 6 embodiment. In the Figure 7 embodiment, outer side 75 is convex. Leading side 77 is blunter than the other embodiments, but still sharper or narrower than trailing side 79. Clearance 80 has a minimum width at leading side 77 and diverges toward trailing side 79.

In the embodiment of Figure 8, diverter head 81 has a flat inner side 83 and an outer side 85 that is considerably move concave than in Figure 6. Leading side 87 is much narrower than trailing side 89 as in the other embodiments. Inner side 83 is perpendicular to radial line 59

(Figure 3), thus it is parallel to a tangent line of annular wall 37. Inner side 83 is located substantially on a diametrical line. Clearance 90 has its minimum width midway between leading side 87 and trailing side 89. The widths of clearance 90 at leading side 87 and trailing side 89 are the same. Although clearance 90 converges to a lesser width in a direction from leading side 87 toward trailing side 89, a significant nip area is not created at the minimum width location because of the much greater diameter of annular wall 37 than the diameter of the cylindrical base of diverter head 81.

In the embodiment of Figure 9, diverter head 91 has flat inner side 93, a flat outer side 95, a sharp leading side 97 and a truncated flat trailing side 99. Inner side 93 is perpendicular to radial line 59 (Figure 3) in the same manner as in the embodiment of Figure 7. As in the embodiment of Figure 7, clearance 100 has its minimum width midway between leading side 97 and trailing side 99.

The invention has significant advantages. The wedge-shaped diverter head deflects drilling cuttings and debris away from the seal gland area. The narrow clearance between the inner side of the diverter head and the annular wall avoids a nip area that could otherwise draw debris between the head and the annular wall.

While the invention has been shown in only five of its forms, it should be apparent to those skilled in the art that it is not so limited but is susceptible to various changes without departing from the scope of the invention. For example, a concave outer side could be used with either a flat or a concave inner side. A convex outer side could be used with either a flat or concave inner side. Also, the diverter head could locate within an annular groove formed in the backface.